GO solar CALIFORNIA

CSI RD&D PROGRAM

Cross-Cutting

Grantee:
BIRAenergy

Phase I Partners:
General Electric, San Diego Gas and Electric, Sunverge

CSI RD&D Funding:
Phase I: $999,999
Phase II: $74,500

Match Funding:
Phase I: $962,557
Phase II: $108,788

Project Timeframe:
Phase I: 2010-2013
Phase II: 2014-2015

RD&D Project Portal:
Phase I
calsolarresearch.ca.gov/csi/74
Phase II
calsolarresearch.ca.gov/csi/117

Itron | CSI RD&D PROGRAM MANAGER

Solar Re-Roofing and the Evaluation of a Zero Net Energy Residential Retrofit

OVERVIEW AND OBJECTIVES

The overall goal of these two research projects was to reduce the first cost barrier for zero net energy (ZNE) residential retrofits. For the first phase of the project, the BIRAenergy team focused on testing General Electric's (GE) new low-cost PV system (Grid-Ready Plug-and-Play PV Kit) as a cost-effective retrofit measure during a residential re-roof. Six test homes were selected in the San Diego Gas and Electric (SDG&E) territory. One of the test homes received a zero net energy (ZNE) home retrofit, which included additional efficiency measures, GE's demand-responsive appliances, an integrated home energy management (HEM) system, and an energy storage system. Phase II of the research focused on the monitoring and evaluation of this ZNE retrofit home.

Phase I: The PV kit was installed on six homes in different climates and on different house styles to evaluate and develop a new business model to increase the market penetration of rooftop PVs, particularly in the retrofit market. The evaluations included installation procedures and processes, training approaches, materials and processes, electricity generation, and integration with other energy and/or power saving retrofits in a ZNE home. Research results from all aspects of the installations, combined with market research, reviews, and assessments of financing programs formed the basis from which an innovative business model for the PV kit was developed.

Phase II: A more extensive evaluation of this ZNE retrofit home involved the testing of the interactions between the PV, distribution and battery storage systems, and demand response (DR) through different operational modes of the home. These included occupant control through the HEM system and utility operation of DR and storage to provide load management.

This document provides a brief project description. For more detail on the project and the California Solar Initiative's (CSI) Research Development, Demonstration & Deployment (RD&D) Program, please visit calsolarresearch.ca.gov

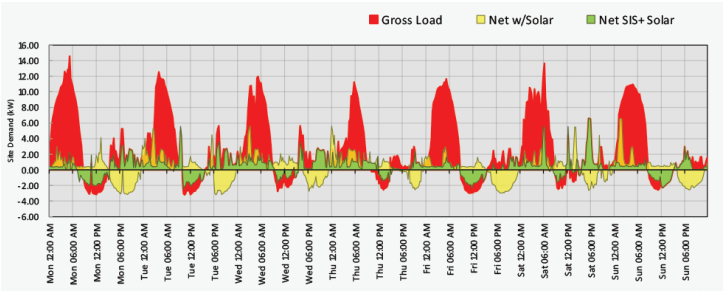
The CSI RD&D Program is managed by Itron on behalf of the California Public Utilities Commission (CPUC).

PHASE I: METHODOLOGY

The BIRAenergy team conducted an evaluation of the GE Plug-and-Play PV Kit including an analysis on system components and installed costs. Innovative financing approaches were identified and reviewed for installing PV along with energy efficient upgrades. The team developed an innovative business model appropriate for the PV kit that could increase the rate of market adoption of rooftop PV, especially in the retrofit market. Lastly, the team evaluated the integration of energy efficiency, demand response, HEM system and energy storage, and PV in the ZNE home.

PHASE I: RESULTS AND OUTCOMES

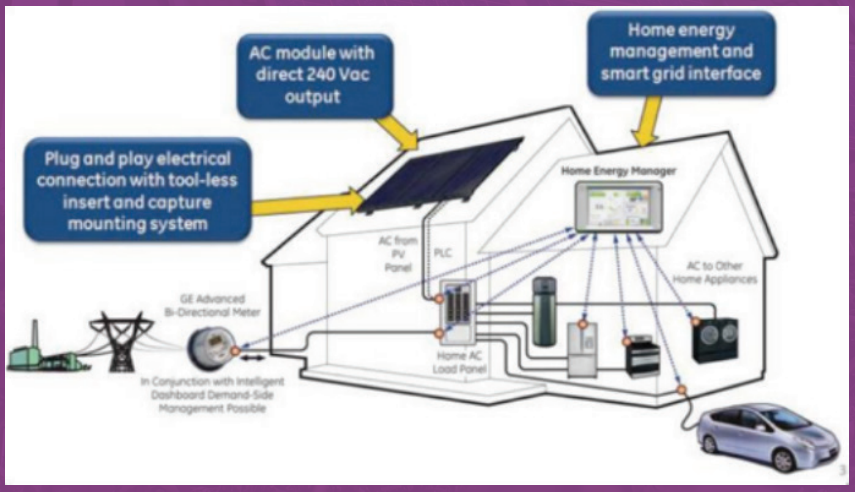
The successful installations and subsequent evaluation demonstrated that the Grid-Ready Plug-and-Play PV Kit can provide roofing contractors with a business opportunity and a whole new market channel by adding PV installations to their product offerings. The roof-top installation can be completed entirely by a trained roofing contractor and one or two assistants. A best practices training guide was developed for both the roofing contractor and electrician contractor, providing detailed instructions for the installation of the PV kit. At the start of this research project, GE estimated the PV kit would have an installed cost below $4/Watt, assuming a 1,000-unit production volume, with the system cost expected to drop to below $3/Watt by the end of 2014. The PV kit employs PVac panels that are connected in parallel instead of the typical PVdc panels that are connected in series. This results in the PV kit arrays being relatively insensitive to shading, compared with the typical dc string arrays. This can be a very important factor to energy production and cost-effectiveness in the retrofit market, where shading is a prevalent problem.



Total home electricity demand (red), demand from the utility meter when generation from the PV is included (yellow), and net demand with PV, energy storage, and electricity needed from the grid (green). Data is the average for each day of the week for October 2013.

PHASE II: METHODOLOGY

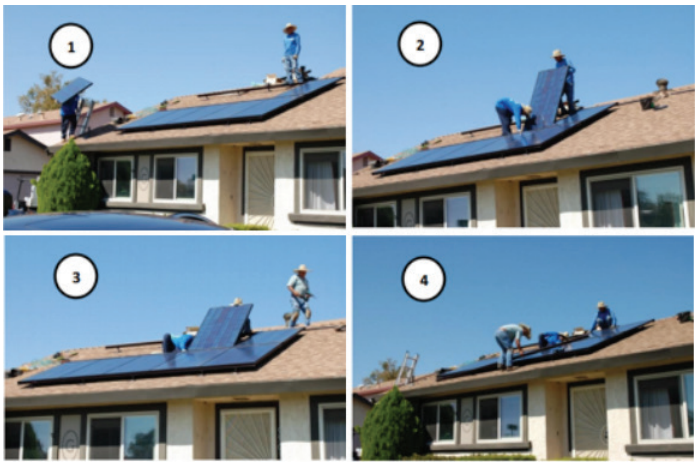
For the second phase of the project, the BIRAenergy team continued the data collection which began during the first phase. The team collected additional 15-minute interval data for an 18-month period, resulting in approximately four years of energy use and generation data from the occupied home: 1.5 years pre-retrofit and 2.5 years post retrofit. Simulations of the baseline home (before retrofits) were compared with the home's actual energy use under baseline conditions. The team examined the ZNE design's performance and impacts on energy reduction summer peak-demand.



GE Smart Grid Ready Residential Solar Electric System

PHASE II: RESULTS AND OUTCOMES

The efficiency package was developed to provide zero net energy on a site basis. While the retrofitted efficiency package did not reach this goal, site electricity was reduced by over 70%, as determined by a comparison of baseline, pre-retrofit data to post-retrofit. This project also showed that DR as a peak-reduction tool is much more valuable in standard homes as compared to ZNE homes. During peak periods, the ZNE home's electricity use is negative (net producer) and therefore does not have a peak to reduce. In contrast, the baseline home had a distinct and higher peak than the ZNE, which can be substantially reduced by DR actions during the peak period. The energy storage system was programmed to charge the batteries using PV energy generated in off-peak hours that exceeds the home's energy demand and to discharge stored electricity when insolation and PV output decline. This programmed charging and discharging out the demand curve, benefitting the utility more than the consumer. The data from this research project has been useful in the evaluation of ZNE-retrofit performance compared with building simulations, the lack of effectiveness of DR in ZNE homes, and insights into the use of residential battery-storage and their value to consumers and to utilities.



Panel installation: 1) Bring panel onto roof. 2) Insert panel into bottom rail. 3) Connect to electrical harness. 4) Capture panel with top rail.

PUBLIC BENEFITS

This project successfully tested, demonstrated, and evaluated the new GE Grid-Ready Plug-and-Play PV Kit and found that it is a valuable addition to the PV market, based on its performance and relatively low cost.

New market channel: The PV kit provided proof of concept and practical implementation of a new class of residential retrofit PV products. The successful installations and subsequent evaluations show that the PV kit provides a new business opportunity for roofing contractors to expand their market offerings.

A new, cost-effective retrofit PV product: At less than $4/Watt, this system was below the market prices for residential retrofits in 2013. Ease of installation results in an overall cost savings by minimizing labor requirements.

Excellent performance: In addition to being less expensive than most competing products, the PV kit performed as well or better than computer simulations predicted.

Shade tolerance: The use of AC modules in the PV kit make it much less affected by shading than the (predominant) PVdc systems. Given that shading is a key barrier to the retrofit market, this tolerance could remove this market barrier to wide-spread adoption of PV on existing homes.

The features in the ZNE home provided a dramatic reduction in peak-demand from the home, and the smart storage system provided the capability to shape residential loads to assist the utility with grid optimization, while being transparent and unobtrusive to the homeowner.

The extensive data sets captured during the nearly 4-year monitoring period of the ZNE home are available to others conducting relevant research.